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RFX-BRK

OPERATORS MANUAL

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1 GENERAL SAFETY INFORMATION

The information that follows, together with local site regulations, must be studied by personnel concerned with the operation or maintenance of the equipment, to ensure awareness of potential hazards.

WARNING- RF Power Hazard : High levels of RF power are present in the unit. Exposure to RF or microwave power can cause burns and may be harmful to health.
Switch off supplies before removing covers or disconnecting any RF cables, and before inspecting damaged cables or antennas.

Avoid standing in front of high gain antennas (such as a dish) and never look into the open end of a waveguide or cable where RF power may be present.

Users are strongly recommended to return any equipment that requires RF servicing to RF Central.

WARNING- GaAs / BeO Hazard : Certain components inside the equipment contain Gallium Arsenide and Beryllium Oxide that are **toxic substances.** Whilst safe to handle under normal circumstances, individual components **must not** be cut, broken apart, incinerated or chemically processed. In the case of Beryllium Oxide, a white ceramic material, the principal hazard is from the dust or fumes which are carcinogenic if ingested, inhaled or entering damaged skin.

Please consult your local authority before disposing of these components.

CAUTION- Tantalum Capacitors : When subjected to reverse or excess forward voltage, ripple current or temperature these components may rupture and could potentially cause personal injury.

CAUTION : This system contains MOS devices. Electro-Static Discharge (ESD) precautions should be employed to prevent accidental damage.

1.1 Health & Safety
Exposure to Non Ionising (RF) Radiation/Safe Working Distances

The safe working distance from a transmitting antenna may be calculated from the relationship:

$$D = \sqrt{\frac{P_T . G_R}{4\pi . w}}$$

in which D = safe working distance (metres)
PT = transmitter or combiner power output (watts)
GR = antenna gain ratio = anti log (gain dBi ÷10)
w = power density (watts/square metre)

The RF power density value is determined by reference to safety guidelines for exposure of the human body to non-ionising radiation. It is important to note that the guidelines adopted differ throughout the world and are from time-to-time re-issued with revised guidelines. For RF Central use, a maximum power density limit of 1w/m² is to be applied when calculating minimum safe working distances. Appendix A refers.

Important Note: It must be remembered that any transmitting equipment radiating power at frequencies of 100 KHz and higher, has the potential to produce thermal and athermal effects upon the human body.

To be safe:

a) Operators should not stand or walk in front of any antenna, nor should they allow anyone else to do so.

b) Operators should not operate any RF transmitter or power amplifier with any of its covers removed, nor should they allow anyone else to do so.

Worked examples

Antenna			**Transmitter Power**			
Type	**Gain (dBi)**	**Gain Ratio**	**2W**	**4W**	**10W**	**30W**
OMNI	4	2.5	1	1	1.5	2.5
HELIX	20	100	4	5.6	9	15.5
PARABOLIC DISH	35	3,162	22.5	32	50	87
			MINIMUM SAFE DISTANCE (METRES)			

1.2 Maximum RF Power Density Limits

The RF Radiation Power Density limit figure recommended by RF Central is based upon guideline levels published in:

a. IEEE standard C95.1 1999 - IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz.

b. Guidelines for Limiting Exposure to Time-varying Electric, Magnetic & Electromagnetic Fields (up to 300 GHz) published in 1998 by the Secretariat of the International Commission on Non-Ionising Radiation Protection (ICNIRP).

Both documents define guideline RF power density limits for "Controlled" and "Uncontrolled" environments. An uncontrolled environment is defined as one in which the person subjected to the RF radiation may be unaware of and has no control over the radiation energy received. The uncontrolled environment conditions can arise, even in the best regulated operations and for this reason the limits defined for the uncontrolled environment have been assumed for the RF Central recommended limit.

Documents a) and b) also show the RF power density guidelines to be frequency dependent. Different power density / frequency characteristics are presented in the two documents. To avoid complexity and to avoid areas of uncertainty, RF Central recommends the use of a single power density limit across the frequency range 100 KHz to 300 GHz. The 1w/m² power density limit we recommend satisfies the most stringent of the guidelines published to date.

Footnote: The IICNIRP document may be freely downloaded from the internet at www.icnirp.de/emfgdl (PDF file).

1.3 Issue Status

Issue	Date	Changes
Issue 1	6th Jan. 2006	first issue

2 INTRODUCTION

The RF Central RFX-BRK ultra compact transmitter is designed for all applications, both indoor and outdoor, in which a very small light weight transmitter is essential to the operation. The unit features a comprehensive range COFDM modulation formats, QPSK 16QAM, 64QAM. Set-up of the unit – e.g. RF channel, MPEG coding profile, COFDM modulation format – is via the 16 position rotary switch on the front panel. PC software is supplied to allow RF channel and COFDM modulation parameters to be pre-programmed for each of the 16 preset positions.

The transmitter is a single miniature unit that contains a MPEG2 video encoder, audio encoder, COFDM modulator, RF power amplifier and power supplies, all of which are mounted on a single printed circuit broad inside the case.

The transmitter is designed to accept analogue video (NTSC or PAL) and 2 analogue audios at line level. Powering is +9 to 18 VDC.

The unit can be used with a variety of RF Central antennas:

- ”F1 patch”, a small low profile antenna which matches the ultra compact features of the transmitter
- Omni antennas are typically used for ground based fixed and mobile operations, or helicopter air to ground
- Low profile antennas are used for up-linking ground to air, or on-board linking
- Helix antennas offer increased gain and directivity
- Fan-beam antennas offer increased gain and 90 degree sector coverage.
- GPS steered antenna, for helicopter air to ground
- Parabolic antennas offer the highest gain, and longest operational range

At the receive site a range of RF Central digital receivers may be used. Please consult the separate RF Central manual for information detailing the operation of receivers.

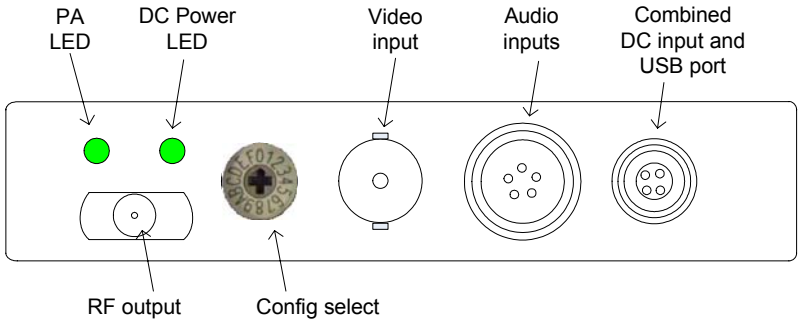
3 SPECIFICATIONS

3.1 RFX-BRK Transmitter Specifications

Frequency Band	1.99 – 2.50GHz band
Tuning Range	500MHz standard bandwidth. Wider bandwidths available to special order
Frequency Selection	Up to 16 pre-set channels, user editable in 0.5MHz steps
Transmit Power	100mW or higher, subject to customer requirements
Transmit Antenna	Interfaces with the complete range of RF Central antennas
Modulation	COFDM DVB-T 2k
Modulation Modes	QPSK, 16QAM, 64QAM FEC: $^{1}/_{2}$ $^{2}/_{3}$ $^{3}/_{4}$ $^{5}/_{6}$ $^{7}/_{8}$ Guard interval: $^{1}/_{32}$ $^{1}/_{16}$ $^{1}/_{8}$ $^{1}/_{4}$
Data Rate	4.98 to 24 Mbit/s
Bandwidth	8MHz
Encoding Options	MPEG 2: 4:2:0 high quality video (DVB standard)
Latency	Selectable to less than 7 frames minimum, Tx to Rx
Video Input	Analogue: Composite video (PAL/NTSC)
Audio Input	Analogue: 1 x stereo/ 2 x mono inputs, line level
Remote set-up	via USB port and PC software
Power Requirement	9 – 18VDC (10W at 12VDC)
Size	148mm (L) x 99mm (W) x 20mm (H) (excluding connectors)
Weight	400g (14.12oz)
Environmental	Temperature: -4° to +122°F Altitude: 14,500 ft. Humidity: 95% long term

Specifications may alter at the discretion of RF Central or to meet customer specific requirements.

4 FRONT PANEL LAYOUT AND PIN CONNECTIONS



Front panel view of the RFX-BRK

4.1.1 Analogue video (BNC connector)

Composite video, PAL or NTSC.
75Ω BNC connector

4.1.2 Audio Connector

Line level

5 Pin Lemo Plug ECG.1B.305.CLN

Pin	Function
1	0V (Screen)
2	Ch1 +
3	Ch1 -
4	Ch2 +
5	Ch2 -

4.1.3 Power and Data Connector

Dual purpose connector:
- DC input
- USB data port

Connector Type: 4 pin LEMO connector EGG.OB.304.CLN

Input range: 10V to 18V DC.

Pin	Function
1	+12V
2	0V
3	Cont. RXD
4	Cont. TXD

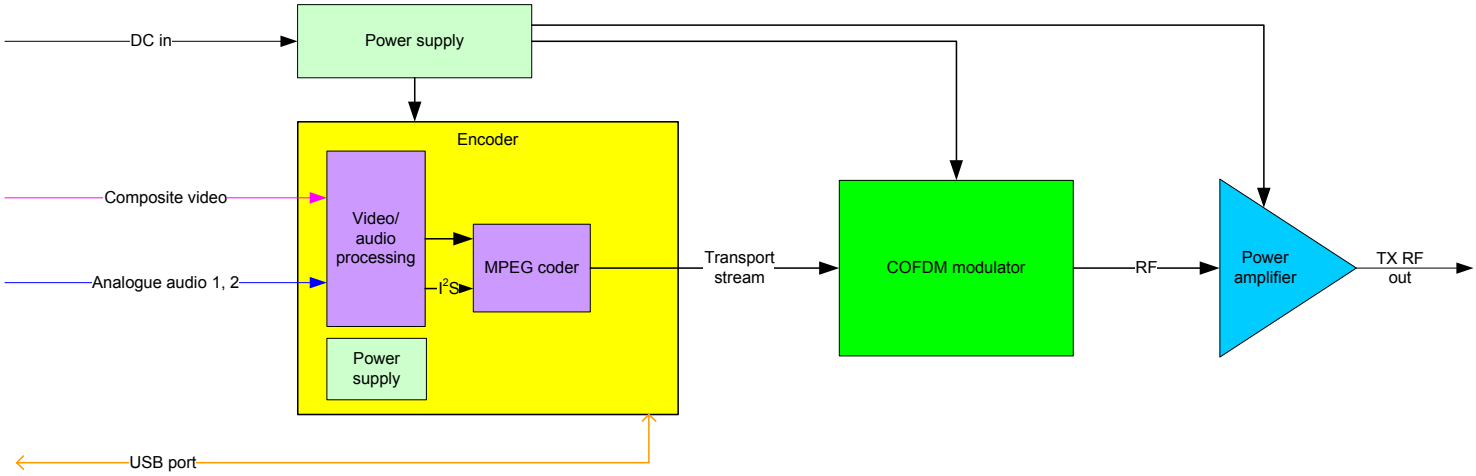
Note: operators are recommended to use the USB Data cable supplied by RF Central to connect from the RFX-BRK to the PC.

4.1.4 RF O/P

Connector Type: 50Ω SMA

5 CIRCUIT DESCRIPTIONS

RFX-BRK Simplified block diagram



CDT TX
Simplified block diagram

The complete RFX-BRK board; individual functions of the PCB are as follows:

5.1 Audio / Video Encoder

The Encoder has the following main functions :

- Analogue to Digital Video Converter, 10 bit over sampling ADC
  Takes Composite Video in either PAL / NTSC format and converts to an 8bit parallel digital video bus.

- Audio Analogue to Digital Converter, 48kHz, 24 bit
  Two high impedance analogue inputs at Line level. The audio channels are converted into digital signals and passed to the MPEG2 Encoder.

- MPEG2 Encoder
  Compresses the video and audio. The encoder uses a suite of MPEG2 compliant compression techniques, where the data bit rate is reduced by processing over multiple picture frames. The RFX-BRK MPEG encoder operates at MP@ML (4.2.0) only. Low data rates down to 4 Mbps, can be achieved.

  The encoding parameters are loaded into the encoder at power up. These are selected by the 'preset' rotary switch position. See 6.2

- DC Power Supplies
  DC/DC converters are used to generate the various supplies from the incoming 9-18V battery supply. These include 2.5, 3.3V, 5V, 8V and 1.2V.

5.2 COFDM Modulator

The normal scheme of COFDM modulation adopted by RF Central for the RFX-BRK is 2k carriers with 8MHz RF band-width.

The COFDM modulator has been designed to take its input from the MPEG2 encoder. This Transport stream is then modulated directly to the output frequency band (e.g. 2GHz). This method reduces the occurrence of inter-modulated harmonic frequencies, requires less upconvertors, and results in a smaller size for the RFX-BRK transmitter.

The modulator is automatically configured to match the data rate of the MPEG2 Encoder as defined by the selected parameter set. See paragraph 6.2

5.3 Power Amplifier

The function of the power amplifier is to amplify the signal from the COFDM modulator to a suitable level for transmission via the SMA-type connector into the antenna. The amplifier is required to be highly linear to accommodate the multiple carrier signal formats employed for digital system operation, with very low distortion (low inter-modulation between carriers). The nominal output power is +20dBm (100mW) (band specific)

The status of the PA is provided by an LED to monitor RF output level (blue), see paragraph 6.1

5.4 Maintenance of the RFX-BRK

To ensure good RF practice, when power is applied to the RFX-BRK, always make sure that there is a suitable load or antenna connected to the RF output.

There are no field replaceable parts on the unit PCB. If a fault occurs with the board, please contact RF Central for technical assistance.

6 CONFIGURING THE TRANSMITTER

6.1 Status Monitoring

There are two status LEDs on the front panel of the unit

- **Power LED**
  - Green = DC power is applied to the unit.
  - Flashing = normal operation

- **PA LED**
  - Blue = the PA is on.

6.2 Preset configuration rotary selector switch

The front panel rotary selector switch allows selection of the 16 preset configurations which are loaded into the unit.

Each RFX-BRK transmitter is pre-programmed with factory defaults for each of the 16 pre-set positions. The standard defaults are shown in appendix A (paragraph 8). These can be edited and updated at any time using RF Central proprietary software through a USB port and PC or Lap Top computer.

The following operating parameters may be set:-

- RF channel (TX operating frequency in 0.5MHz steps)
- MPEG encoder bit rate
- COFDM modulator operating mode
  - QPSK, 16QAM, 64QAM
  - Viterbi FEC rate
  - Guard interval

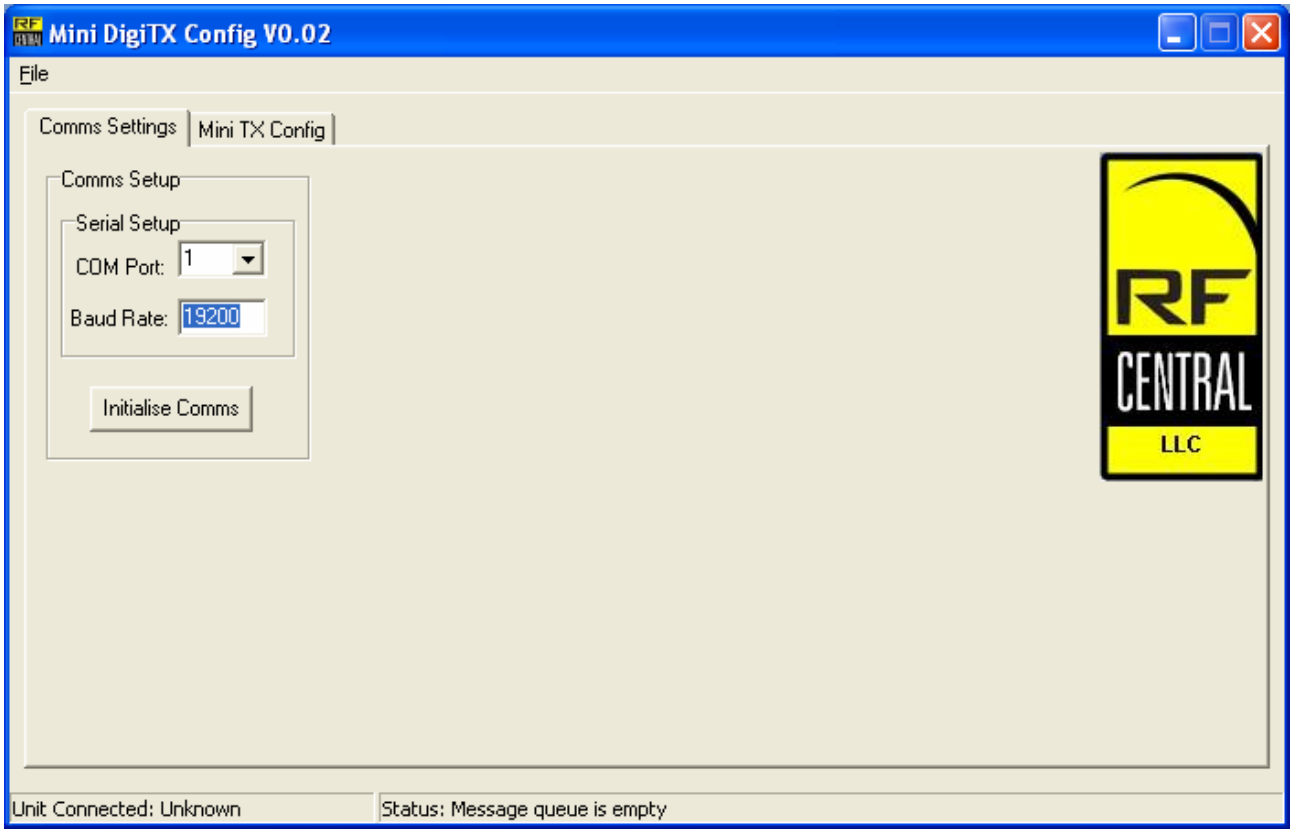
6.3 Remote set-up of the 16 preset configurations.

PC software is supplied to allow each of the 16 preset rotary switch positions to be pre-programmed according the operator's desired RF channel and COFDM modulation parameters.

The RFX-BRK transmitter is connected to the PC via the combined DC/USB Lemo connector. When connecting to the PC the user is recommended to use the USB data cable supplied by RF Central which is fitted with the correct Lemo connector - see 4.1.3.

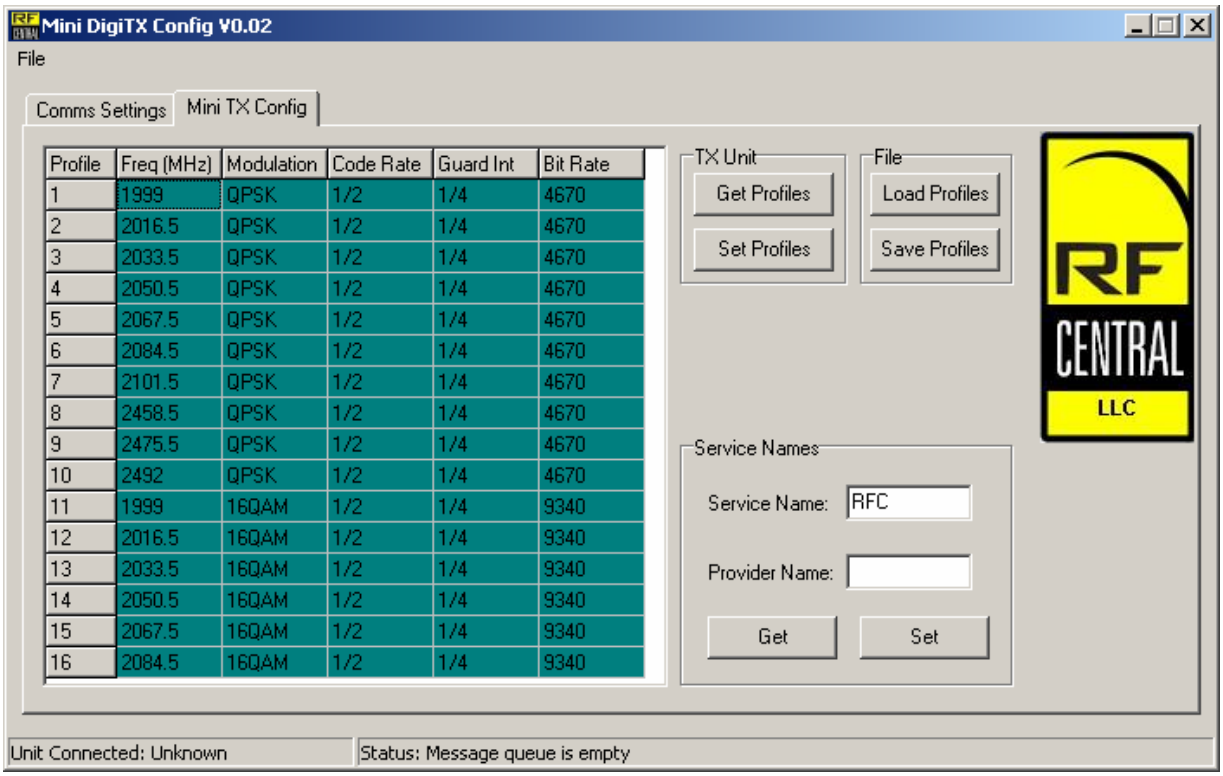
The required sequence when re-programming the profile information into the RFX-BRK transmitter is as follows:

- Connect the power/data Lemo connector into the RFX-BRK.
- Switch on the power to the transmitter.
- Connect the USB lead to the PC.
- Start the programming software by double clicking on the file *MiniDigiTXConfig.exe*.
- If required change the software for the correct comm. port by selecting the tab *Comms Settings*.



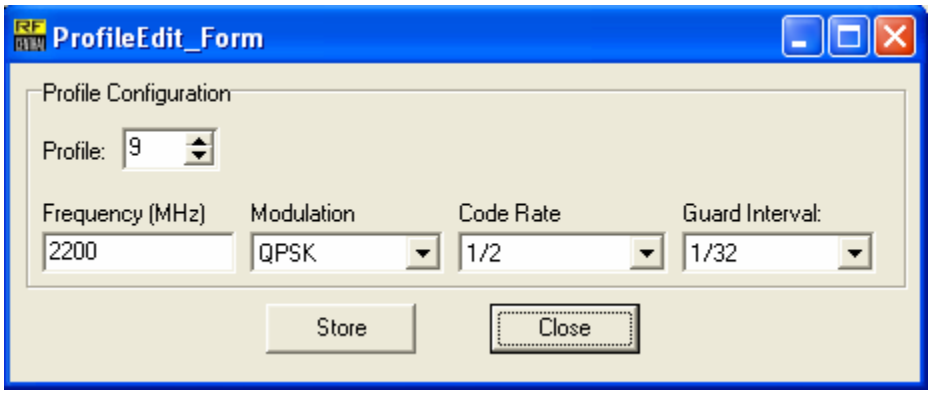
To re-configure the 16 sets of profile parameters:

- Select the tab *Mini TX Config.*



- To open a profile already stored on the PC click *File/Load Profiles* , and choose/open the required .pf file in the normal Windows manner
- Similarly, to open the file already stored in the RFX-BRK TX click *TX unit/Get Profiles*

To modify a profile double click the required profile number, this opens the *Profile Edit Form*



- Modify the frequency by typing into the box, and change the modulation, code rate and guard interval from the drop down list.
- *Store* each profile as it is updated.
- repeat for other profiles as required
- on completion select the *Close* button

- To save the new profile to the computer click *File/Save Profiles*
- To save the new profile to the RFX-BRK transmitter click *TX Unit/Set Profiles*

7 PREPARING FOR OPERATION

EQUIPMENT PREPARATION

Before leaving the equipment base to undertake an operation it is recommended that the following equipment checks be made.

7.1 The RFX-BRK Transmitter

7.1.1 Antennas

The unit can be used with a variety of RF Central antennas:-

- ”F1 patch”, a small low profile antenna which matches the ultra compact features of the transmitter
- Omni antennas are typically used for ground based fixed and mobile operations, or helicopter air to ground
- Low profile antennas are used for uplinking ground to air, or on-board linking
- Helix antennas offer increased gain and directivity
- Fan-beam antennas offer increased gain and 90 degree sector coverage.
- GPS steered antenna, for helicopter air to ground
- Parabolic antennas offer the highest gain, and longest operational range

Full details are given in the RF Central Antennas data sheet

7.1.2 Transmitter checks

The transmitter may be powered from an external AC/DC PSU, or by batteries. Check that any batteries to be used are fully charged and that an emergency spare battery is available and fully charged.

Confirm that the correct pre-set RF channel and modulator operating mode is selected by the rotary switch on the front panel.

7.2 The Receiving Equipment

The RFX-BRK mini transmitter may be used with a variety of RF Central digital receivers.

Full details on the operation of the receiver are given in the associated manuals.

When used with the RFX-BRK transmitter, the receiving equipment produces two audio channels, analogue and AES3 digital, together with SDI and composite video monitoring port. The RFX-RMR receiver also has an ASI output.

Check that audio, video, triax, AC and DC cables of sufficient total length and are in good condition. If extension cables are necessary ensure that the connectors are compatible and of good quality to avoid problems at site.

Check that the receiving antenna/Receiver interfaces are clean and free from dust and other unwanted materials.

If tripods are to be used to mount the equipment, make sure that some means of securing the tripod or of weighting it down is provided. Gusty wind conditions may put installations at risk, particularly when parabolic antenna dishes are to be used.

Make sure that all batteries to be used are fully charged and, whenever possible, provide a spare with cable to connect it to the receiver.

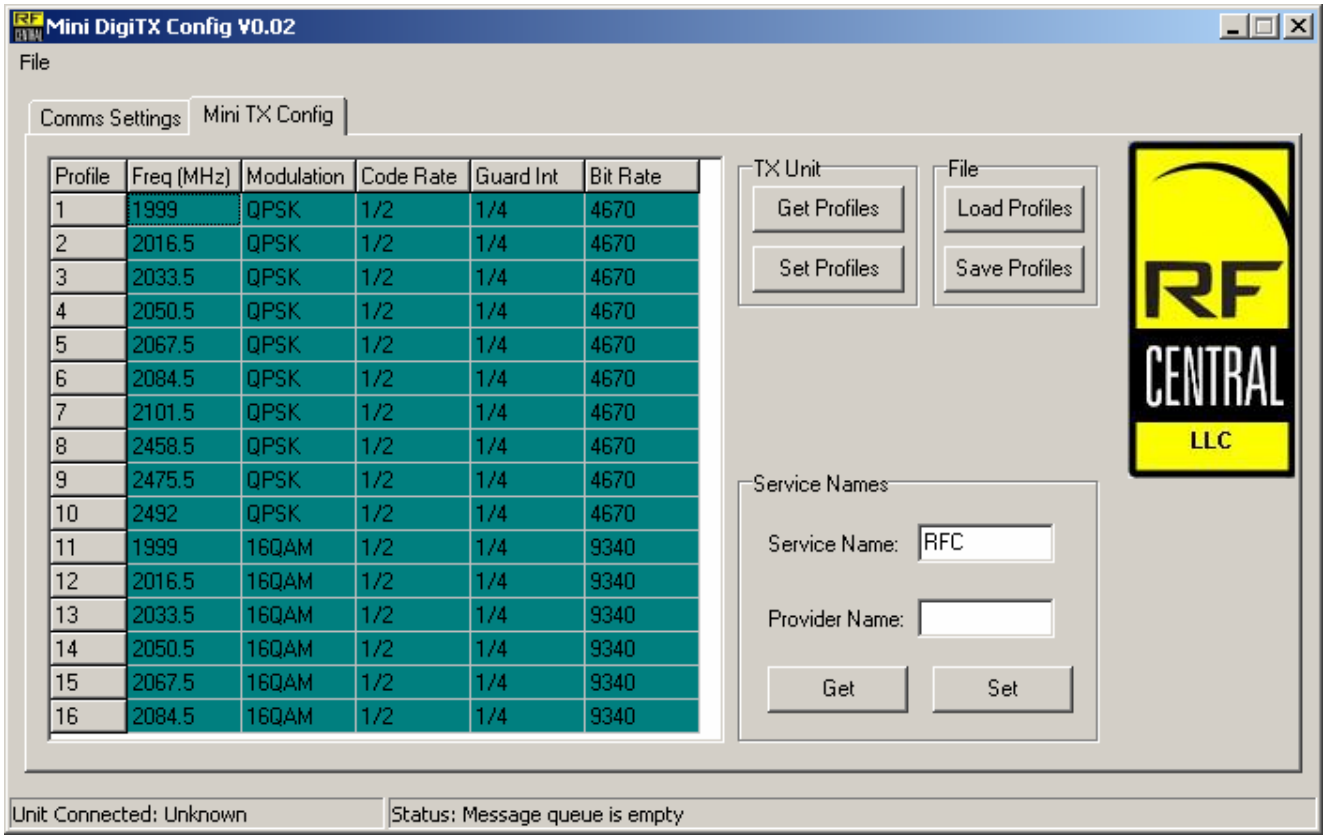
Check that the receiver channel frequencies are compatible with those of the RFX-BRK Transmitter. The receiver is labelled with channel number and frequency information.

7.3 Transmitter / Receiver tests

Whenever practical, set up the system and trial it before leaving for site to ensure that all components of the system are working. Checking at base, where adjustments and corrective actions can be made, will pay off when setting up at site.

8 Appendix A

Example of 16 Factory pre-sets


Mini DigiTX Config V0.02
File
Comms Settings
Mini TX Config
Profile | Freq (MHz) | Modulation | Code Rate | Guard Int | Bit Rate
1 | 1999 | QPSK | 1/2 | 1/4 | 4670
2 | 2016.5 | QPSK | 1/2 | 1/4 | 4670
3 | 2033.5 | QPSK | 1/2 | 1/4 | 4670
4 | 2050.5 | QPSK | 1/2 | 1/4 | 4670
5 | 2067.5 | QPSK | 1/2 | 1/4 | 4670
6 | 2084.5 | QPSK | 1/2 | 1/4 | 4670
7 | 2101.5 | QPSK | 1/2 | 1/4 | 4670
8 | 2458.5 | QPSK | 1/2 | 1/4 | 4670
9 | 2475.5 | QPSK | 1/2 | 1/4 | 4670
10 | 2492 | QPSK | 1/2 | 1/4 | 4670
11 | 1999 | 16QAM | 1/2 | 1/4 | 9340
12 | 2016.5 | 16QAM | 1/2 | 1/4 | 9340
13 | 2033.5 | 16QAM | 1/2 | 1/4 | 9340
14 | 2050.5 | 16QAM | 1/2 | 1/4 | 9340
15 | 2067.5 | 16QAM | 1/2 | 1/4 | 9340
16 | 2084.5 | 16QAM | 1/2 | 1/4 | 9340
TX Unit
Get Profiles
Set Profiles
File
Load Profiles
Save Profiles
RF CENTRAL LLC
Service Names
Service Name: RFC
Provider Name:
Get
Set
Unit Connected: Unknown
Status: Message queue is empty

Note: The above parameters denote factory pre-sets for the RFX-BRK and are issued for guidance only. Some transmitters may have different configurations according to individual customer requirements. Please consult the documentation supplied with the equipment for the details applicable to your system. All factory pre-sets may be edited using the RF Central proprietary software mentioned in paragraph 6.3

9 Appendix B

Table of DVB-T non-hierarchical bit rates

Modulation	Code rate	Bit rate (Mbit/s) at each guard interval (symbol fraction)			
QPSK		1/32	1/16	1/8	1/4
	1/2	6.03	5.85	5.53	4.98
	2/3	8.04	7.81	7.37	6.64
	3/4	9.05	8.78	8.29	7.46
	5/6	10.1	9.76	9.22	8.29
	7/8	10.6	10.2	9.68	8.71
16-QAM		1/32	1/16	1/8	1/4
	1/2	12.1	11.7	11.1	9.95
	2/3	16.1	15.6	14.7	13.3
	3/4	18.1	17.6	16.6	14.9
	5/6	20.1	19.5	18.4	16.6
	7/8	21.1	20.5	19.4	17.4
64-QAM		1/32	1/16	1/8	1/4
	1/2	18.1	17.6	16.6	14.9
	2/3	24.1	23.4	22.1	19.9
	3/4	27.1	26.3	24.9	22.4
	5/6	30.2	29.3	27.6	24.9
	7/8	31.7	30.7	29.0	26.1